

SHEET (1)
Second low of thermodynamic, Entropy and Carnot cycle

1- Explain the two statements of the second law of thermodynamics?

2- What are the factors that make processes irreversible?

3- What do you know about the Carnot principles?

4- What do you know about the isentropic process – what are the isentropic relations which belong to P, T and V?

5- A person claims to have designed an engine that receives 52.5 kJ of heat and produces 13 kJ of useful work, when operating between a source temperature of 60°C and sink temperature of 0°C. is this claim valid?

6- Which is more efficient for increasing the efficiency of a reversible engine operating between the temperature two thermal reservoirs at 1000 K and 400 K

   a. increasing the temperature of the hot reservoir by 100 K , keeping the temperature of the cold reservoir , or ,
   b. Decreasing the temperature of the cold reservoir by 100 K, keeping the temperature of the hot reservoir constant.

Comment on the results.

7- A Carnot engine receives heat from constant temperature reservoir at 400°C and rejects heat at 100°C to 4 kg water. As the engine operates the water is heated at constant pressure and its temperature increase by 50°C.Calculates the work output of the Carnot cycle.

8- An engine operating on the Carnot cycle between the temperature limits 500 K and 350 K receives 1000 kJ of heat and the heat rejected is delivered to a building for heating purpose. The work from these engines drives a heat pump operating on the reversed Carnot cycle between the temperature limits 225 K and 330 K and the rejected heat is delivered to the same building. Calculate the total amount of heat which delivered to the building.

9- Air is used in a Carnot engine, where 25 kJ of heat are received at 773 K and heat rejected at 543 K. The displacement volume is 0.135 m^3. Determine the cycle work and the mean effective pressure.

10- Consider a refrigerator and a heat pump, both of them taking and rejecting same amounts of heat (Qin and Qout), choose the correct answer and give appropriate explanations:

11- A refrigeration cycle having a coefficient of performance of 3 is used to maintain a computer laboratory at 18°C on a day when the outside temperature is 30°C. The thermal load inside the laboratory at steady state consists of energy entering through the walls and windows at a rate of 30,000 kJ/h and from the occupants, computers, and lighting at a rate of 6000 kJ/h. Determine the power required by this cycle and compare with the minimum theoretical power required for any refrigeration cycle operating under these conditions, each in kW.

12- A Carnot heat engine receives heat from a reservoir at 900°C at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27°C. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at 5°C and transfers it to the same ambient air at 27°C. Determine (a) the maximum rate of heat removal from the refrigerated space and (b) the total rate of heat rejection to the ambient air.

13- Two reversible engines A & B operate in series between 1000 K and 400 K. The engines thermal efficiencies are equal. The heat received by engine A is 500 kJ. Determine:

a) The temperature of the heat rejected by engine A.
b) The work of engine A and B.
c) The heat rejected by the engine B.

14- An air- standard Carnot cycle is executed in a closed system between the temperature limits of 77°C and 927°C. The pressure before and after the isothermal compression are 50 and 300 kPa, respectively. If the net work output per cycle is 0.5kJ, determines,

a- represent the cycle on the P- v and T-s diagrams,
b- The maximum pressure in the cycle,
c- The heat transfer to air,
d- The mass of air.

(For air take: R = 0.287 kJ/kg.K, and cp = 1.005 kJ/kg.K)